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**FIELD EMITTER ARRAY RF AMPLIFIER DEVELOPMENT PROJECT
ARPA CONTRACT #MDA 972-91-C-0028
PHASE ONE, OPTION 1**

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**SPONSORED BY:
DR. BERTRAM HUI
ARPA/DSO**

**SPECIAL TECHNICAL REPORT
31 JAN 94**

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**MCNC ELECTRONIC TECHNOLOGIES DIVISION
POST OFFICE BOX 12889
RESEARCH TRIANGLE PARK, NC 27709-2889
GARY MCGUIRE, PRINCIPAL INVESTIGATOR**

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11. SUPPLEMENTARY NOTES Dr. Palmer (919) 248-1837, (919) 248-1455 FAX COTR: Dr. Bertram Hui (703) 696-2239, (703) 696-2201 FAX				
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13. ABSTRACT (Maximum 200 words) MCNC has duplicated and improved upon test results documented in the Special Technical Report dated 17 JAN 94. Tables detailing the measured 1 GHz modulation of the field emitter array anode current are included, as is a printout of an oscilloscope screen displaying our best results. A net power gain at 1 GHz of +7.74 dB was observed with 161.9 μ A of modulated anode current at a DC bias current of 1.8 mA. Continued improvement is expected.				
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MCNC has duplicated and improved upon test results documented in the Special Technical Report dated 17 JAN 94. Tables detailing the measured 1 GHz modulation of the field emitter array anode current are included, as is a printout of an oscilloscope screen displaying our best results.

On 21 JAN 94, modulation of the anode current at 1 GHz was observed twice from two separate 1,197-tip arrays with a gate capacitance of 2.2 pF. The modulation levels observed were consistent with the measurements documented in the previous report. In these tests, however, much greater DC bias currents were achieved. The data for these tests is shown in Tables 1 and 2. In each case, the measured modulated anode current and net power gain at low bias currents is consistent with the previous test, and increases with increasing bias current, as is expected. A maximum net power gain of +2.60 dB was observed in both cases, with the device in Table 1 producing 70 μ A of modulated anode current and the device in Table 2 producing 30 μ A of modulated anode current. The difference in the modulation at the output is due to and consistent with the difference in the input power used for each test.

After these tests, a modification of the test fixture was made that allowed reduction of the cathode-to-anode spacing by 50%. This greatly increased the DC emission current available at the anode during testing at high frequencies. The increase in anode current provides a corresponding increase in measured net power gain.

Modulation at 1 GHz was demonstrated again on 26 JAN 94, with another 1,197-tip array that gave a maximum of 1.8 mA of measured emission current. The measured gate capacitance for this device was also 2.2 pF. The data for this test is shown in Table 3. Again, at low bias the results are consistent with other measurements. As the anode current is increased, there is a corresponding increase in the observed anode current modulation and net power gain. At the highest bias point, a measured net power gain of +7.74 dB was observed. This represents nearly an order of magnitude improvement over the results reported earlier.

Figure 1 is a printout of the DSA602A oscilloscope screen displaying the feedthrough signal after calibration due to cathode-to-anode capacitance, and the measured voltage signal due to 1 GHz modulation of the field emitter array anode current. The RMS amplitude of the feedthrough signal after calibration is less than 1 mV. This signal is measured with no emission current. When the field emitter array is operating, each additional millivolt of measured RMS voltage corresponds to 12.65 μ A peak of modulated anode current. The RMS amplitude of the output signal due to the modulated anode current is over 11 mV, corresponding to peak modulated anode current of 161.9 μ A, and well above the feedthrough signal observed before calibration.

In summary, MCNC has duplicated and improved upon the 1 GHz modulation results reported earlier. A net power gain at 1 GHz of +7.74 dB was observed with 161.9 μ A of modulated anode current at a DC bias current of 1.8 mA. Continued improvement is expected.

DC Bias Current (μA)	Modulated Anode Current (μA)	Net Power Gain (dB)
200	12.4	+0.52
300	19.4	+0.80
400	36.7	+1.46
530	51.9	+2.00
700	70.0	+2.60

Table 1: Results of RF test on 21 JAN 94 at MCNC. Net gain is calculated relative to the feedthrough signal at -50 dB. Input power to the test fixture is 0.2 W at a measurement frequency of 1 GHz.

DC Bias Current (μA)	Modulated Anode Current (μA)	Net Power Gain (dB)
100	1.5	+0.52
300	8.9	+0.80
600	19.0	+1.46
720	27.6	+2.00
880	30.0	+2.60

Table 2: Results of the second RF test on 21 JAN 94 at MCNC. Net gain is calculated relative to the feedthrough signal at -52 dB. Input power to the test fixture is 0.1 W at a measurement frequency of 1 GHz.

DC Bias Current (μA)	Modulated Anode Current (μA)	Net Power Gain (dB)
100	8.4	+0.62
125	14.7	+1.06
280	29.7	+2.03
540	50.1	+3.20
1100	102.5	+5.62
1250	116.4	+6.16
1500	137.9	+6.94
1800	161.9	+7.74

Table 3: Results of RF test on 26 JAN 94 at MCNC. Net gain is calculated relative to the feedthrough signal at -55 dB. Input power to the test fixture is 0.1 W at a measurement frequency of 1 GHz.

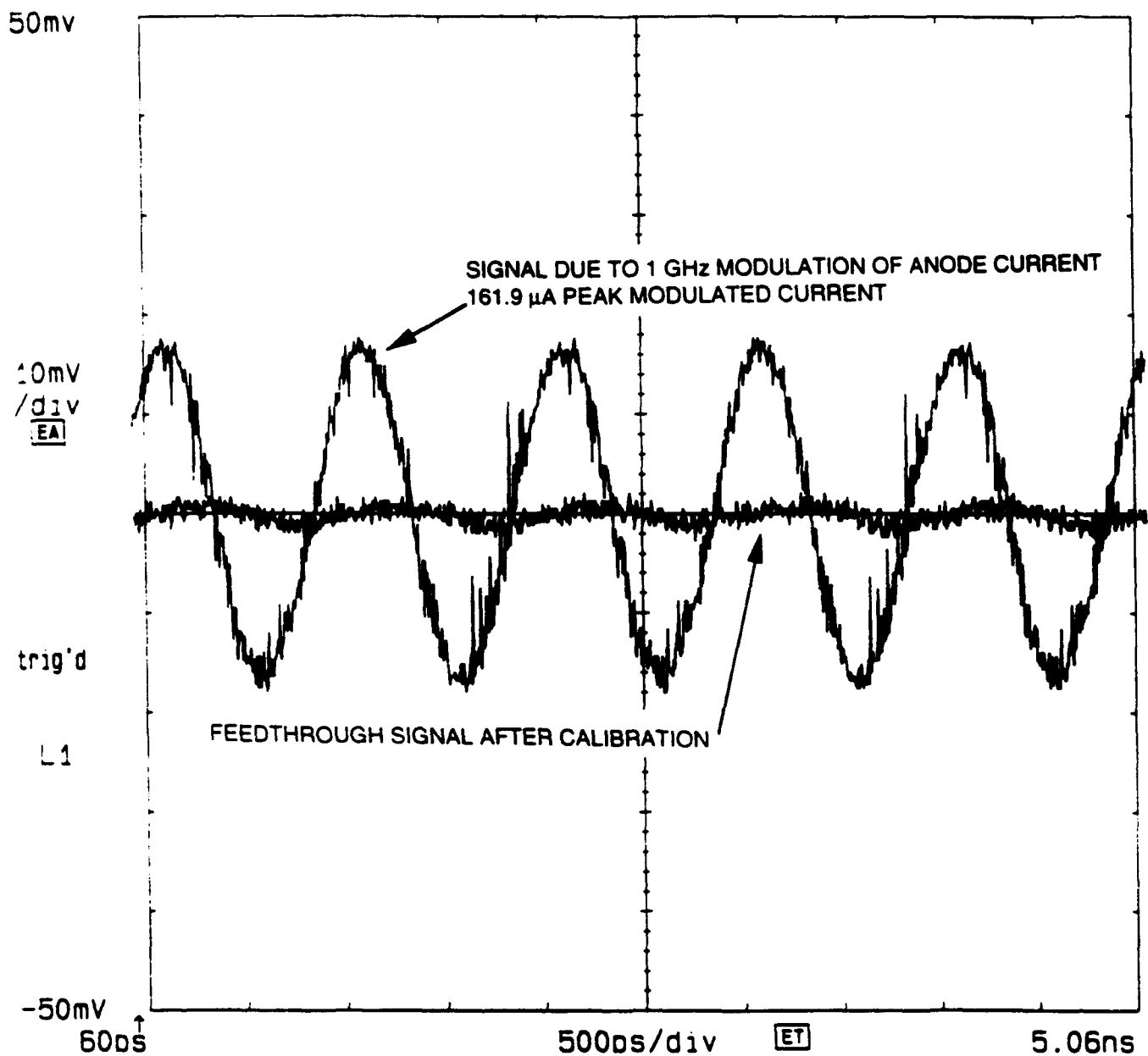


Figure 1: Printout of the DSA602A oscilloscope screen displaying the feedthrough signal after calibration due to the cathode-to-anode capacitance, and the voltage signal due to 1 GHz modulation of field emitter array anode current. The RMS amplitude of the output signal is over 11 mV, corresponding to a peak modulated anode current of 161.9 μ A, and well above the feedthrough signal observed before calibration.